Deep Learning Enhanced Fidelity InSAR Toolkit (DEFIT), Phase I

Completed Technology Project (2018 - 2019)

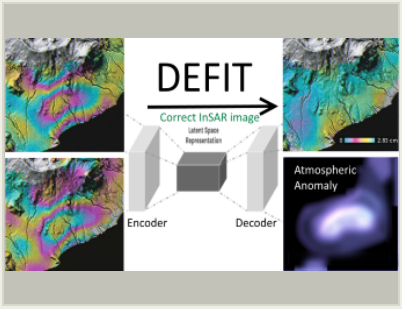
Project Introduction

Lynntech, in collaboration with Southern Methodist University (SMU) Earth Sciences, proposes to develop a new deep learning-based toolkit that is useful for enhancing the fidelity of results derived from Interferometric Synthetic Aperture Radar (InSAR) interferograms. The automated deep learning tool performs a spatial–temporal analysis of multiple InSAR images, to yield a high fidelity estimate of the deformation of the topography and estimate of atmospheric water vaper when a recent Digital Elevation Model is also known. There are existing methods used by earth science experts to detect and mitigate the atmospheric anomaly that effects the time of flight of backscattered radar, either from multiple InSAR images or when integrating other sources of elevation or meteorological observations or models. The automated image reconstruction algorithm will minimize a loss function, an inferred empirical error based on a large sample set, rather than the heuristic or incompletely modeled statistical algorithms currently employed, through a three-step process: first detect the regions affected by the atmospheric anomaly, and then second without *a-priori* knowledge use a generative network to reconstruct the interferogram or deformation map without the atmospheric effect, and use another network to train the loss function to evaluate the generator's result and adjust its internal parameters. This type of approach has not been implemented for InSAR imagery, but has been applied to similar image processing problems and generalized to other tasks. This tool is meant for big data analysis of very fast revisit InSAR that covers the entire globe. Lynntech and SMU-Earth Science propose to develop and validate this approach for developing a new image processing tool in Phase I , while developing the deep learning enhanced fidelity InSAR toolkit in Phase II and III, raising the TRL from 2 to 4 within the Phase I work plan and planning for testing on relevant datasets in Phase II.

Anticipated Benefits

This technology would be useful to many Earth science and meteorological applications involving changes in terrain, ecology and the weather. Digital elevation models can be produced and updated in near real-time. Ground level deformations due to various processes could be monitored on almost a daily basis. Also highly fidelity spatio-temporal analysis of fast revisit InSAR data to track changes in the Earth's surface and atmosphere would help in the zenith dry delay correction of GPS signals.

Regularly monitoring changes in the ground would be useful in disaster prediction and recovery (e.g. mudslides, flooding, sinkholes), evaluating the settling of infrastructure, preventing property damage and is also vital to land management strategies. Estimating atmospheric water vapor would assist in nowcasting. InSAR imagery can be useful in decision making in a wide range of applications. SAR imagery enhancement algorithms, with a few changes, can be used in other terrestrial applications.



Deep Learning Enhanced Fidelity InSAR Toolkit (DEFIT), Phase I

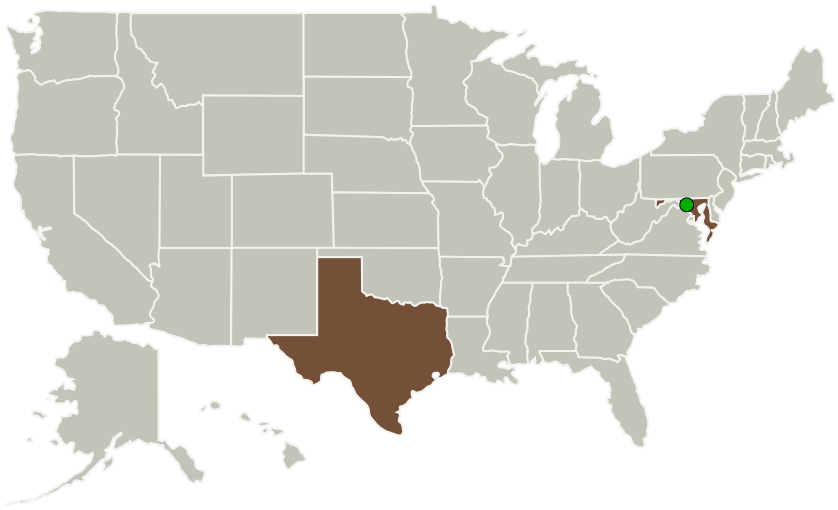
Table of Contents

Project Introduction	1
Anticipated Benefits	1
Primary U.S. Work Locations and Key Partners	2
Project Transitions	2
Organizational Responsibility	2
Project Management	2
Images	3
Technology Maturity (TRL)	3
Technology Areas	3
Target Destination	3

Deep Learning Enhanced Fidelity InSAR Toolkit (DEFIT), Phase I

Completed Technology Project (2018 - 2019)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Lynntech, Inc.	Lead Organization	Industry	College Station, Texas
Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations	
Maryland	Texas

Project Transitions

July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141001)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Lynntech, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Jason Hill

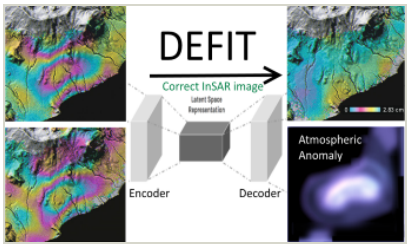
Co-Investigator:

Jason A Hill

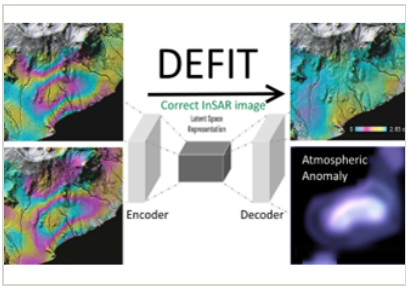
Deep Learning Enhanced Fidelity InSAR Toolkit (DEFIT), Phase I

Completed Technology Project (2018 - 2019)

Images



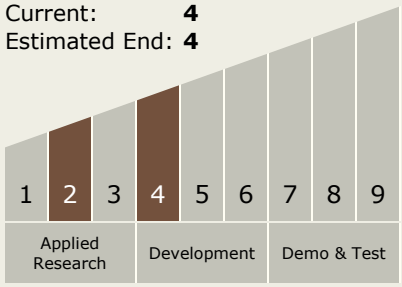
Briefing Chart Image
Deep Learning Enhanced Fidelity InSAR Toolkit (DEFIT), Phase I *(https://techport.nasa.gov/image/136528)*



Final Summary Chart Image
Deep Learning Enhanced Fidelity InSAR Toolkit (DEFIT), Phase I *(https://techport.nasa.gov/image/130286)*

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.4 Microwave, Millimeter-, and Submillimeter-Waves

Target Destination

Earth